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CURRENTS OF AIR AND OCEAN

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IN

CONNECTION WITH CLIMATES,

REGIONS OF SUMMER RAINS AND SUMMER DROUGHTS.

BY

J. BEAUFORT HURLBERT, LL. D.,  
OF OTTAWA, CANADA.

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CURRENTS OF AIR AND OCEAN IN CONNECTION WITH CLIMATES,  
REGIONS OF SUMMER RAINS AND SUMMER DROUGHTS. By J.  
BEAUFORT HURLBERT, of Ottawa, Canada.

[ABSTRACT.]

THE prevailing winds in the north temperate zone are from southwest towards the northeast. This great current of air may be said to be constant north of latitude  $35^{\circ}$ . In the upper region of the air it blows nearly every day in the year from some point near the southwest towards the northeast. With a constant movement of the air in high altitudes from the southwest there must be a return current from the north towards the southwest, as there are counter currents in the ocean; but these polar winds near the surface of the earth blow from all the colder points of the compass.

The warm currents of air and water falling upon western coasts, and aerial currents passing over the continents, elevate the temperatures of the western parts of the continents, while the cold currents pressing upon eastern shores lower the temperatures there.

The mean temperature of the Gulf stream in the Gulf of Mexico is  $80^{\circ}$  Fahrenheit; its maximum temperature is  $86^{\circ}$ , or  $9^{\circ}$  above the ocean temperature due the latitude. Increasing its latitude  $10^{\circ}$ , it loses two degrees of heat, and after running 3,000 miles towards the north still preserves the temperature of summer. With this temperature it crosses the fortieth degree of north latitude, and spreading out for thousands of square leagues over the cold waters of the ocean, does much to mitigate the rigors of winter in Europe. When it strikes the British islands it divides into two parts, the main current going to the Polar sea, the other entering the Bay of Biscay.

It has been estimated that the quantity of heat discharged over the Atlantic, from the waters of the Gulf stream in winter, would be sufficient to raise the whole column of atmosphere which rests upon France and the British islands from the freezing point to summer heat. Every western wind which blows (and the prevailing winds are from the west or from some point near the west or southwest in this part of the ocean) crosses the Gulf stream and carries with it a portion of its heat, discharging it in its pas-

sage over Europe. The isothermal lines of  $60^{\circ}$  and  $55^{\circ}$ , starting from the parallel of  $40^{\circ}$  on the American coast, run in a northeasterly direction, retaining nearly the same oceanic temperature on the European side in latitude  $55^{\circ}$  and  $60^{\circ}$  as exists on the American coast in latitude  $40^{\circ}$ .

In the Pacific there are tropic and arctic currents like those in the Atlantic, and from similar causes. The Japan stream, or Kuro-Siwo — black stream — a name derived from the deep blue color of its waters, flows from the southeast of Asia in a northeasterly direction, falling upon the western coast of North America. This stream, flowing many thousand miles further than the Atlantic tropic current, is not so hot nor its littoral waters so cold as those in the Atlantic, but it spreads over the entire Pacific coast of Canada. These two currents in the Pacific — the arctic and tropical — produce similar effects to those in the Atlantic; the one warming the western coast of North America, in high latitudes, and the other cooling the eastern shores of Asia.

Through the agency of these two currents in the Atlantic, the western countries of Europe are much warmer than the eastern parts of America in similar latitudes; the difference being about eight degrees in latitude  $41^{\circ}$ ; eleven and a half in latitude  $51^{\circ}$ ; and twenty-five in latitude  $58^{\circ}$ . Similar causes in operation in the Pacific ocean give an equal elevation of the temperature of the western coasts of America over the eastern coasts of Asia in the same latitudes — the arctic currents chilling the one and the tropical currents warming the other.

From Vancouver in latitude  $49^{\circ}$  to Sitka in  $57^{\circ}$ , the summer temperatures are as high and as uniform as in the west of Europe, except where the vicinity of mountains may modify the normal conditions of climate. Sir John Richardson says "the climate of Sitka" (on the Pacific coast) "is much warmer than that of Europe in the same parallel" (*Arc. Ex.*, Vol. II, p. 279).

The isothermal of  $60^{\circ}$  for the three summer months rises as high as latitude  $63^{\circ}$  east of the Rocky mountains in the valley of Mackenzie river. Youkon, west of Mackenzie river and within the Arctic circle, latitude  $67^{\circ}$ , has a July  $65^{\circ} 7'$ , and an August of  $60^{\circ}$ .

In comparing the well known regions of the old world with the less known corresponding parts of the new, western coasts with western, eastern with eastern, and interior divisions with interior,

we find a remarkable similarity in the climates of the two continents. Canton, in China, latitude  $23^{\circ}$ , has a summer temperature of  $82^{\circ}$ , and Key West, in Florida, latitude  $24^{\circ}$ ,  $32'$ , a summer of  $82^{\circ}$ . Pekin, latitude  $40^{\circ}$ , has a summer of  $76^{\circ}$ , which is only two or three degrees above that of Philadelphia of the same latitude. Mangas-aka, Japan, and Charleston, South Carolina, in the same latitudes, have summers of  $80^{\circ}$ . London, in the west of Europe, and Vancouver, in the west of North America, in similar latitudes, have the same mean summer temperatures, about  $61\frac{1}{2}^{\circ}$ ; Sitka, in latitude  $57^{\circ}$ , Sir John Richardson says, has a climate much warmer than Europe in the same latitude.

The climates of the interior are warmer in summer and colder in winter than those on eastern and western coasts, but are somewhat similar on both continents, being, however, warmer on the Red, Saskatchewan, and Mackenzie rivers, than in the same parallels on the eastern continent. The isothermal of  $65^{\circ}$ , for the three summer months, crosses the Red river in latitude  $50^{\circ}$ , and rises on the Mackenzie to latitude  $60^{\circ}$ .

The summer rains, too, throughout Canada, are similar to those in Europe in the same latitudes from the Mediterranean to the Arctic, being somewhat uniform during the agricultural months, but more copious in Canada.

South of the boundary between Canada and the United States, west of the Mississippi, are the areas of summer droughts — a rainless, treeless region, similar in position on this continent, and in the character of the country to the desert areas of the old world — the one beginning on the western coasts of Mexico and California, and extending to British America on the north, and over half the continent eastward; the other beginning on the western coast of Africa near the same latitude as the American desert, and extending northeastward or east by north over Africa, Palestine, Independent Tartary and Manshire Tartary, nine thousand miles in the direction of the prevailing winds.

That portion of the North American continent extending from the Atlantic westward more than 2,000 miles in the latitude of Canada, and from the Gulf of Mexico for 1,500 miles northward, is covered with a mixed forest of conifere and deciduous trees, which is unparalleled in extent, and in the variety and value of its woods.

These forests, so beautiful and grand in their primitive state,

have a value quite independent of their money worth. They have a most powerful and favorable influence upon the climates of the country, check evaporation, and keep the water longer in the soil, thus supplying the roots of plants, feeding the springs and streams, etc.

West of this vast forest, south of the parallel of  $48^{\circ}$  or  $49^{\circ}$ , is the treeless region. The Mississippi may be taken as near the boundary of these two zones marked with such different features, the forest in many places not reaching that river, in others extending beyond it, and again reappearing on the Pacific coast. East of the Mississippi trees appear first along the water-courses and on soil retentive of moisture, being still absent on the uplands and sandy plains. To the north this immense treeless region runs, in the country of the Upper Missouri (longitude  $110^{\circ}$  west), north of latitude  $50^{\circ}$ . Throughout these immense areas there is either a total absence of rain in summer, as in the desert parts, or an insufficiency, as on the prairies. The grasses which cover parts of these dry up in summer, but their roots, forming a deep matted sod, have vitality enough to put forth fresh shoots under the rains of spring and autumn; trees, however, which are withered up by the droughts and arid winds of summer, have no such vitality.

Vast portions of America, Africa, Asia and Australia, are destitute of trees, while other equally extensive regions are covered with forests. These treeless zones lie in similar positions on the continents, beginning near the same latitudes on the western coasts and running northeastward in the northern hemisphere, and southeastward in the southern, in the direction of the prevailing winds.

In the Old World (for Europe, Asia and Africa must, on the question of climates, be taken as one body of land) these treeless and mainly desert regions begin on the west coast of Africa, north of the twentieth parallel, and run northeastward or east by north, 9,000 miles over Africa, Palestine, northern Arabia, and Independent Tartary to latitude  $50^{\circ}$  in Mongolia, ending in the great desert of Cobi or Manshire Tartary.

In North America we have a similar desert-treeless region, beginning in old and new California and on the coasts of Mexico (in the same latitudes as the African desert), and extending to the Mississippi and beyond it, on the east, and to British America

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on the north. The winds over these desert areas on both continents blow almost invariably in summer from some point near the southwest towards the northeast. These portions of the continents are destitute mainly of summer rains, but have high summer temperatures. Upon the modifications caused in these desert areas by the high lands of Mexico and the vast Mediterranean sea we cannot here enter, but may merely state that the mountains of Mexico limit the deserts there, and that great sea north of Africa causes a more humid air in the south of Europe and limits the deserts in that direction; yet Spain, Italy, Sicily, and the whole country northeastward into Hungary, frequently suffer from summer droughts.

The reason, as a permanent cause, often assigned for these portions of the continent being destitute of trees—namely, the prairie fires—cannot for a moment bear investigation.

Fires were naturally suggested to the first rude settlers, to whom the evidence of sight is the chief guide, as the only cause. In many parts of the African, Asiatic and American deserts and prairies there are no fires, still they are treeless. In other countries, fires are as frequent where forests are permanent, or, if burned down, young trees immediately grow up again. The existence of forests over a region 2,000 miles by 1,000, and their failure *where, and only where*, the summer rains fail and the arid winds prevail, ought to have suggested the explanation.

That the prairie fires sweeping over extended areas may have kept trees from some localities, near rivers or on retentive soils, is possible; but such exceptions, limited and local, have no weight in opposition to the fact that millions of square miles have remained, through all the ages of history, desert and treeless on the borders of other equally extensive areas covered with dense forests. The climates which have produced these two distinct results over those regions have remained permanent for ages, and will remain permanent in the future, unless changes supervene in the entire solar system; but for the calculation of such imaginary phenomena astronomy furnishes no data. We may infer, therefore, that those conditions of climate—heat and humidity in the one case, and heat and aridity in the other—remaining the same, their effects—forests and treeless regions—will be permanent expressions of those fixed efficient causes.

The attempts to account for the deserts of the Old and New

World by the physical configuration of the continents, have led to many ingenious theories. The chief of these is the assumption that mountain chains to the west of those rainless regions condense the vapor brought in the southwest winds, causing heavy rains on the western sides of the mountains, but leaving the winds without vapor east of these mountain chains. The phenomena of rain on the west, but none on the east of the Ghauts in Hindostan and other places, have been taken as sufficient bases for this theory.

That those regions having no summer rains are on similar parts of the continents north and south of the equator, both in the eastern and western hemispheres, beginning on western coasts at about the same latitudes; that there are no mountains west of the Desert of Sahara, and the rainless regions in Australia; that the entire coasts of Mexico, old and new California, west of the mountains, are quite as destitute of rain in summer as the regions east; that those west winds give heavy falls of rain to the north and northeast throughout Canada, and in autumn, winter, and early spring, deposit heavy rain and snow on those interior desert areas east of the Rocky mountains, over which they are said to pass in summer, devoid of vapor,—these and other facts ought to have corrected the erroneous opinions on this subject.

That the great southwest currents of air—the tropical currents—bring the vapor which falls in rain and snow, is here assumed as admitted, for it is the basis of the theory which we are controverting.

Those vast wastes are, at the season of the year when little or no rain falls, highly heated by the summer suns. The southwest winds passing over these become rarefied, and thus, being capable of sustaining even more vapor than at a lower temperature, retain the humidity with which they have come from the tropics so heavily charged, till they reach the cooler regions, north and northeast, where they are condensed into rain or snow. Hence in summer the line dividing the zones of rain from those of drought is farther to the northeast; as autumn and winter approach, those highly heated plains gradually cool sufficiently to condense the vapors in the southwest winds, which now give heavy depositions of rain and snow.

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